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GIFFORD PINCHOT, Forester.

GRADES AND AMOUNT OF LUMBER

SAWED FROM

YELLOW POPLAR, YELLOW BIRCH, SUGAR MAPLE, AND BEECH.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., February 7, 1906.

SIR: I have the honor to transmit herewith a manuscript entitled "Grades and Amount of Lumber Sawed from Yellow Poplar, Yellow Birch, Sugar Maple, and Beech," by Edward A. Braniff, Forest Assistant, Forest Service, and to recommend its publication as Bulletin 73 of the Forest Service.

Respectfully,

GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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GRADES AND AMOUNT OF LUMBER SAWED FROM YELLOW POPLAR, YELLOW BIRCH, SUGAR MAPLE, AND BEECH.

INTRODUCTION.

A definite need of the lumber manufacturer to-day is exact and detailed information concerning the quality of the product which his trees yield. Every sawmill produces a large amount of lumber of inferior grades, which is difficult to sell and which usually brings a price less than the average cost of production. The poor grades come in highest proportion from the small trees. As a tree increases in size the proportion of choice grades increases; in other words, there is both a quantity and a quality increment. Lumbermen are well aware of this tendency, and attempt to shape their logging policy in accordance with it. They plan to cut only the trees which will yield enough good lumber to more than pay for the loss incurred through handling the poor grades. But lumbermen have no precise information as to the dividing line between profitable and unprofitable trees, and for lack of this information many of them are cutting a good deal of timber at an actual loss.

It is evident that a knowledge of the graded yield of trees is of advantage even to the lumberman who has no intention of managing his lands with a view to future timber crops. A knowledge of what he is getting from each tree will tend to make his logging policy conservative, and he will refuse to cut those trees which he knows to be unprofitable. But for the lumberman who is considering the conservative management of his lands specific information as to the value of his trees is far more advantageous. Most lumbermen who undertake to practice forestry must leave some of their small trees uncut as a basis for future timber crops. These small trees may be barely profitable, or wholly unprofitable; in either case the lumberman wants

to know what is the present value of his lumber and how it compares with that which his trees will yield when they have reached a larger size.

The Forest Service has endeavored to determine, in typical localities and under good conditions of manufacture, the graded yield and the money value of some important commercial trees. It should be borne in mind, however, that the figures obtained will by no means fix absolutely the graded yield and the value of the species studied over their entire range of growth. The character of timber changes in different localities and in different situations within the same locality; the conditions governing its logging control the manner and extent of each tree's utilization; the demands of a given market regulate methods of manufacture; the efficiency of the mill and of the mill crew affects the quality and quantity of the products; and the nature and application of the grading rules determine results. Therefore the results from no two mills can be exactly similar. Nevertheless, figures such as those given for yellow poplar, yellow birch, sugar maple, and beech give relatively, if not absolutely, the graded yield and the value of the species.

Tallies of the graded yield of yellow poplar were made in two localities, one in the Great Smoky Mountains of southeastern Tennessee, the other in the Cumberland Mountains of the western part of Virginia. Tallies of the Adirondack hardwoods were made at McKeever, Herkimer County, N. Y.

The following method was used in conducting the tallies: Men were in the woods to follow the saw crews and measure and mark the trees after they had been felled. Each tree, and each log in that tree, was given a number, which was marked on the ends with crayon. Thus 129^3 would indicate the third log from tree No. 129. After these logs had reached the mill they were carefully kept track of. The lumber was inspected by a competent inspector and tallied by grades, a separate sheet being used for each log. The talley sheets were arranged according to the breasthigh diameters of the trees, the figures were added and averaged, and the results were tabulated by plotting curves, from which were read the average number of feet of lumber of each grade which the trees of each diameter contained. This is called the graded volume table.[a] A price list, which represented the average selling

[a] It will be seen in Tables II and III that for several of the larger diameters there were no trees to form the basis of graded yield and total volume. The figures for these were secured from the curves. Yellow poplar above 60 inches in diameter is extremely rare, and but few trees larger than this passed through the mill during the period of the study.

price of the different grades of lumber at the mill, was then applied and a table constructed, giving the money value of each diameter class and the average value per thousand feet of the lumber it contained.

The necessity for inspecting the lumber while green interfered slightly with the accuracy of the results. The final inspection of the lumber after it had been seasoned and was being loaded for shipment changed the previous grading, but, where the grades had been carefully made, the change did not exceed 3 or 4 per cent on all combined. Some boards, especially yellow-poplar saps, present an entirely different appearance when seasoned than when green. Drying often sweats out stains which in the green boards appear as defects. On the other hand, drying sometimes exposes hidden knots or, if imperfectly done, causes stains.

The figures procured show the results of methods of logging and milling for all classes of timber cut on the particular tract where the tally was made. The marked logs which passed through the mill were part of the daily cut, no better and no worse than the average run. No matter how defective a tree might be, if it yielded but one log it was included and averaged with the rest. When the character of the timber varies widely in a locality it would be more accurate to make a separate table for each forest type represented; but in the present case one type was so greatly predominant that a division was thought inadvisable.

PART I.—GRADES AND AMOUNT OF LUMBER SAWED FROM YELLOW POPLAR.

THE TENNESSEE TIMBER.

The yellow poplar in Blount County, Tenn., was part virgin, part second growth, of good outward appearance, and little damaged by fire. It was of exceptional size, and grew mostly in coves and hollows along the tributaries of a stream, in mixture with hemlock, silver bell, basswood, buckeye, cucumber, and ash. A relatively small proportion of the timber grew higher up, along the slopes and ridges, in mixture with chestnut, chestnut oak, and shortleaf and white pines. The trees were cut and peeled in the fall, and taken to the sawmill by railroad in the winter and spring. The trees were of good height, as is indicated by the following table, which shows, for each diameter, the average lengths logged.

TABLE I.—*Used length of yellow poplar—Tennessee.*

Diameter breast-high.	Used length.	Diameter breast-high.	Used length.	Diameter breast-high.	Used length.	Diameter breast-high.	Used length.
Inches.	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*
13	36	25	59	37	65	49	67
14	37	26	60	38	65	50	67
15	39	27	60	39	66	51	67
16	41	28	61	40	66	52	67
17	44	29	62	41	66	53	67
18	46	30	62	42	66	54	67
19	49	31	63	43	66	55	67
20	52	32	63	44	66	56	67
21	54	33	64	45	66	57	67
22	55	34	64	46	66	58	67
23	57	35	64	47	66	59	67
24	58	36	65	48	67	60	67

THE TENNESSEE SAWMILL.

The mill was equipped with a single band saw cutting about 60,000 feet daily. The saw was 14-gage, and removed about 1 inch of kerf with every seven cuts. The thickness of the lumber varied from 5/8-inch to 6/4-inch. Out of 2,037,098 feet of lumber sawed from marked logs, 91 per cent consisted of 4/4, 5/4, and 6/4-inch thickness, and 9 per cent of 5/8-inch thickness. The sawyer was an experienced man, and his handling of the timber was satisfactory to the company. One man was employed at the edger and another at the trimmer. They were obliged to do rapid work in order to keep up with the saw, but when serious mistakes were made the boards were thrown off the chain conveyer by the inspector and sent back to be edged or trimmed again. The inspection followed was that of the National Hardwood Lumber Association. Although the slabs were made into lath, it was impracticable with the force available to follow them through the saws, and no account of them was taken in the study. The company estimated about 300 laths to every 1,000 board feet of lumber sawed.

THE RESULTS.

In all, 5,735 logs from 1,407 trees were traced through the mill in the six months during which the study lasted. The graded yield of the trees is given in Table II.

TABLE II.—*Graded lumber sawed out of yellow poplar—Tennessee, 1905.*

Diameter breast-high.	Firsts and seconds.					Saps.	Wide box boards.	Commons.	Shipping culls.	Mill culls.	Total.	Number of trees tallied.
	8–17 inches.	18–23 inches.	24–27 inches.	28–32 inches.	33 inches and up.							
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
13	......	......	......	......	......	2	......	12	55	19	88	7
14	......	......	......	......	......	4	......	17	73	27	121	15
15	......	......	......	......	......	6	......	23	91	34	154	29
16	......	......	......	......	......	9	......	31	109	42	191	45
17	3	......	......	......	......	13	......	40	127	50	233	35
18	6	......	......	......	......	18	......	50	144	58	276	59
19	10	......	......	......	......	25	......	62	162	67	326	69
20	15	......	......	......	......	33	......	75	180	77	380	51
21	23	......	......	......	......	43	1	89	197	86	439	43
22	32	......	......	......	......	56	2	106	215	96	507	61
23	43	......	......	......	......	70	4	124	233	105	579	59
24	59	......	......	......	......	83	7	143	250	115	657	43
25	78	......	......	......	......	96	11	164	268	125	742	65
26	102	......	......	......	......	107	17	186	285	135	832	44
27	132	......	......	......	......	117	24	210	302	139	924	57
28	168	5	......	......	......	124	32	233	319	154	1,035	54
29	206	9	......	......	......	130	41	257	336	163	1,142	42
30	243	14	......	......	......	135	51	282	353	172	1,250	35
31	277	22	......	......	......	139	62	307	370	182	1,359	41
32	309	32	1	......	......	143	73	332	388	190	1,468	41
33	338	47	3	6	......	146	84	357	404	200	1,585	46
34	366	68	5	7	......	148	95	383	421	210	1,703	40
35	392	100	9	8	......	150	107	409	437	220	1,832	41
36	417	105	14	10	......	152	118	435	454	230	1,935	46
37	440	217	23	12	......	154	130	460	471	242	2,149	32
38	462	270	35	15	......	156	143	489	487	254	2,311	30
39	483	329	50	18	......	157	157	515	504	265	2,478	29
40	504	385	69	23	......	158	171	543	519	279	2,651	21
41	524	439	90	30	2	159	185	570	535	293	2,827	25
42	543	472	112	40	4	159	200	598	550	307	2,985	21
43	563	505	136	51	7	159	214	624	565	322	3,146	23
44	582	533	162	65	10	159	228	650	580	339	3,308	14
45	600	556	188	83	17	158	241	676	594	357	3,470	16
46	617	575	216	104	25	157	252	702	609	375	3,632	24
47	634	592	245	129	38	157	260	729	623	394	3,801	17
48	650	606	275	157	56	156	266	755	637	414	3,972	15
49	665	618	302	189	81	155	268	781	652	433	4,144	4
50	681	629	326	222	115	154	268	808	666	452	4,321	10
51	695	638	347	254	160	151	265	834	680	473	4,497	10
52	709	645	364	280	217	149	260	860	694	494	4,672	9
53	723	652	378	302	280	147	253	886	708	515	4,844	5
54	737	658	389	320	348	143	245	911	722	536	5,008	6
55	749	664	398	334	404	139	237	937	735	557	5,154	8
56	762	669	405	345	465	134	228	963	748	578	5,297	3
57	774	673	410	355	524	128	222	989	760	600	5,435	2
58	786	676	415	363	583	123	216	1,015	774	622	5,573	2
59	797	680	419	369	637	117	212	1,040	785	644	5,700	3
60	808	681	421	375	690	110	208	1,066	798	666	5,823	1
61	818	684	423	380	740	103	206	1,092	809	689	5,944	......
62	828	686	425	385	787	95	205	1,118	820	712	6,061	2
63	838	688	426	388	833	87	205	1,143	831	735	6,174	2
64	848	690	427	392	875	84	204	1,170	842	759	6,291	......
65	857	692	427	395	920	70	204	1,195	852	782	6,394	3
66	866	694	428	398	963	62	203	1,221	862	805	6,502	......
67	875	695	428	400	1,005	52	202	1,247	872	828	6,604	......
68	883	697	429	403	1,047	43	202	1,272	882	851	6,709	1
69	892	699	429	405	1,085	33	201	1,298	891	876	6,809	......
70	900	700	430	407	1,125	25	200	1,324	900	900	6,911	1

In order to show the proportion which each grade bears to the total yield of the tree, the graded board feet have been reduced to percentages in the following table:

TABLE III.—*Percentage of each grade sawed out of yellow poplar—Tennessee.*

Diameter breast-high.	Firsts and seconds.					Saps.	Wide box boards.	Commons.	Shipping culls.	Mill culls.	Total yield of tree.	Number of trees tallied.
	8–17 inches.	18–23 inches.	24–27 inches.	28–32 inches.	33 inches and up.							
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	......	......	......	......	......	2	......	14	62	22	88	7
14	......	......	......	......	......	3	......	14	61	22	121	15
15	......	......	......	......	......	4	......	15	59	22	154	29
16	......	......	......	......	......	5	......	16	57	22	191	45
17	1	......	......	......	......	6	......	17	55	21	233	35
18	2	......	......	......	......	7	......	18	52	21	276	59
19	3	......	......	......	......	8	......	19	50	20	326	69
20	4	......	......	......	......	9	......	20	47	20	380	51
21	5	......	......	......	......	10	......	20	45	20	439	43
22	6	......	......	......	......	11	......	21	43	19	507	61
23	8	......	......	......	......	12	1	21	40	18	579	59
24	9	......	......	......	......	13	1	22	38	17	657	42
25	11	......	......	......	......	13	1	22	36	17	742	65
26	12	......	......	......	......	13	2	23	34	16	832	44
27	14	......	......	......	......	13	2	23	33	15	926	57
28	16	......	......	......	......	12	3	23	31	15	1,035	54
29	18	1	......	......	......	11	4	23	29	14	1,144	42
30	19	1	......	......	......	11	4	23	28	14	1,250	35
31	20	2	......	......	......	10	5	23	27	13	1,363	41
32	21	2	......	......	......	10	5	23	26	13	1,473	41
33	21	3	......	......	......	9	5	23	26	13	1,585	46
34	22	4	......	......	......	9	6	22	25	12	1,703	40
35	21	6	1	......	......	8	6	22	24	12	1,832	41
36	22	5	1	1	......	8	6	22	23	12	1,935	46
37	21	10	1	1	......	7	6	21	22	11	2,149	32
38	20	12	1	1	......	7	6	21	21	11	2,311	30
39	20	13	2	1	......	6	6	21	20	11	2,478	29
40	19	14	3	1	......	6	6	20	20	11	2,651	21
41	19	15	3	1	......	6	7	20	19	10	2,827	25
42	18	16	4	1	......	5	7	20	19	10	2,985	21
43	18	16	4	2	......	5	7	20	18	10	3,146	23
44	18	16	5	2	......	5	7	20	17	10	3,308	14
45	17	16	5	2	1	5	7	20	17	10	3,470	16
46	17	16	6	3	1	4	7	19	17	10	3,632	24
47	17	16	7	3	1	4	7	19	16	10	3,801	17
48	16	15	7	4	1	4	7	19	16	11	3,972	15
49	16	15	7	5	2	4	6	19	16	10	4,144	4
50	16	15	7	5	3	4	6	19	15	10	4,321	10
51	15	14	8	6	4	3	6	19	15	10	4,497	10
52	15	14	8	6	5	3	5	18	15	11	4,672	9
53	15	13	8	6	6	3	5	18	15	11	4,844	5
54	15	13	8	6	7	3	5	18	14	11	5,008	6
55	14	13	8	6	8	3	5	18	14	11	5,154	8
56	14	13	8	6	9	3	4	18	14	11	5,297	3
57	14	12	8	7	10	2	4	18	14	11	5,435	2
58	14	12	7	7	11	2	4	18	14	11	5,573	2
59	14	12	7	7	11	2	4	18	14	11	5,700	3
60	14	12	7	6	12	2	4	18	14	11	5,823	1
61	14	12	7	6	12	2	3	18	14	12	5,944	......
62	14	11	7	6	13	2	3	18	14	12	6,061	2
63	14	11	7	6	14	1	3	19	13	12	6,174	2
64	14	11	7	6	14	1	3	19	13	12	6,291	......
65	14	11	7	6	14	1	3	19	13	12	6,394	3
66	13	11	7	6	15	1	3	19	13	12	6,502	......
67	13	11	6	6	15	1	3	19	13	13	6,604	......
68	13	10	6	6	16	1	3	19	13	13	6,709	1
69	13	10	6	6	16	1	3	19	13	13	6,809	......
70	13	10	6	6	16	1	3	19	13	13	6,911	1

TENDENCIES INDICATED BY THE TABLES.

Tables II and III show that although the amount of lumber of each grade increases with the size of the tree, the tendency is for the good

grades rapidly to outstrip the poor ones. Thus, firsts and seconds, saps, box boards, and commons combined increase from only 14 feet, or 16 per cent, in the 13-inch class, to 5,111 feet, or 74 per cent, in the 70-inch class; while the poor grades, shipping culls and mill culls, between the same diameters, though they increase in the aggregate amount of lumber (from 74 to 1,800 feet), show a decrease proportionately from 84 to 26 per cent.

Considering the grades separately, firsts and seconds show a steady increase from the 17-inch class (where they first appear) to the highest diameters. At 17 inches this grade forms only 1 per cent of the contents of the tree; at 70 inches it forms 51 per cent.

Saps and box boards should be considered together, since they are essentially the same kind of lumber, the difference being mainly in width and length of pieces.[a] They increase from 2 per cent in the 13-inch class to 15 per cent in the 26-inch class. This percentage is maintained (with the exception of one diameter, where it drops to 14 per cent) until the 34-inch class is reached, from whence it drops to only 4 per cent in the diameters between 63 and 70 inches. The reason why the percentage of saps drops off above the 27-inch class is that part of the lumber becomes wide enough to grade as box boards. The decrease in percentage of saps and box boards combined is accounted for by the fact that the box boards from large trees become wide enough to grade as firsts and seconds.

The grade commons increases from 14 per cent in the 13-inch class to 23 per cent in the 26-inch to 33-inch classes. From this point part of the commons are wide enough to grade as firsts and seconds, and so the proportion drops (though somewhat irregularly) to 19 per cent. The proportion of shipping culls drops from 62 per cent in the 13-inch class to 13 per cent in the 63-inch to 70-inch classes. The proportion of mill culls drops somewhat irregularly from 22 per cent in the 13-inch class to 10 per cent in the 41-inch to 47-inch classes, then slowly rises again to 13 per cent in the 67-inch to 70-inch classes, owing probably to the high proportion of defects in very large trees.

VALUES FROM THE TENNESSEE TIMBER.

Table II was used as the basis for determining the value of the trees. Prices representing the value of the lumber loaded on cars at the mill were applied, and a table was made which shows the value

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[a] "Sap clears must be 6 inches or over wide, 10 to 16 feet long, but not to exceed 10 per cent of 10-foot lengths admitted, and free from all defects except bright sap."

"Wide box boards must be 13 to 17 inches wide, 12, 14, and 16 feet long, and clear except slightly discolored sap or one sound knot which does not exceed 1 inch in diameter and which shows on one side only, or splits not exceeding 6 inches in length on either end."—Inspection rules, National Hardwood Lumber Association.

of all the lumber for each diameter of tree and the average value of that lumber per thousand feet.

The prices per 1,000 board feet used were as follows:

Firsts and seconds:		Saps	$28
8 to 17 inches in width	$38	Wide box boards	39
18 to 23 inches in width	44	Commons	23
24 to 27 inches in width	48	Shipping culls	11
28 to 32 inches in width	55	Mill culls	8
33 inches and up in width	65		

These prices are based upon yellow poplar of 4/4-inch, 5/4-inch and 6/4-inch thicknesses, which constituted 91 per cent of the total amount sawed. Prior to and during the early part of the study practically all the logs were sawed into these thicknesses, but later a demand developed for 5/8-inch boards for automobile bodies. The 9 per cent of 5/8-inch material sawed reduced somewhat the scale of the logs through excessive saw kerf, but increased their value. Since, however, this method of sawing was not uniform throughout the study but was the result of a special and perhaps temporary demand, and since by accident it affected some diameters much more than others, it seemed best to calculate the values entirely on the basis of the customary thicknesses. The effect of this is, of course, to make the following values very conservative.

TABLE IV.—*Values of yellow poplar—Tennessee, 1905.*

Diameter breast-high.	Amount sawed out.	Value per tree.	Value per thousand board feet.	Diameter breast-high.	Amount sawed out.	Value per tree.	Value per thousand board feet.
Inches.	*Bd. ft.*			*Inches.*	*Bd. ft.*		
13	88	$1.10	$12.50	42	2,985	$83.75	$28.06
14	121	1.52	12.56	43	3,146	89.36	28.40
15	154	1.97	12.79	44	3,308	94.96	28.71
16	191	2.50	13.09	45	3,470	100.72	29.03
17	233	3.19	13.69	46	3,632	106.55	29.34
18	276	3.92	14.20	47	3,801	112.78	29.67
19	326	4.83	14.82	48	3,972	119.27	30.03
20	380	5.82	15.32	49	4,144	126.01	30.41
21	439	7.02	15.99	50	4,321	133.19	30.82
22	507	8.45	16.67	51	4,497	140.52	31.25
23	579	10.00	17.27	52	4,672	147.97	31.67
24	657	11.79	17.95	53	4,844	155.39	32.08
25	742	13.80	18.60	54	5,008	162.58	32.46
26	832	16.04	19.28	55	5,154	168.64	32.72
27	924	18.50	20.02	56	5,297	174.69	32.98
28	1,035	21.42	20.70	57	5,435	180.44	33.20
29	1,142	24.38	21.35	58	5,573	186.10	33.39
30	1,250	27.37	21.90	59	5,700	191.29	33.56
31	1,359	30.40	22.37	60	5,823	196.17	33.69
32	1,468	33.48	22.81	61	5,944	200.92	33.80
33	1,585	37.00	23.34	62	6,061	205.47	33.90
34	1,703	40.50	23.78	63	6,174	209.80	33.98
35	1,832	44.52	24.30	64	6,291	214.07	34.03
36	1,935	47.39	24.49	65	6,394	218.09	34.11
37	2,149	55.11	25.64	66	6,502	222.14	34.16
38	2,311	60.54	26.20	67	6,604	225.93	34.21
39	2,478	66.25	26.74	68	6,709	229.89	34.27
40	2,651	72.19	27.23	69	6,809	233.48	34.29
41	2,827	78.34	27.71	70	6,911	237.21	34.32

The lumber company at whose mill the tally was conducted stated that the average price received for yellow poplar at the mill during the fiscal year 1904–5 was $24.66 per thousand feet. In Table IV we find that this figure corresponds within a few cents with the "value per thousand feet" of a 36-inch tree. The percentage of grades produced and shipped from the mill for the fiscal year should then approximate the percentage of grades from a 36-inch tree. How closely it does so will be seen from the following parallel:

Grade.	Shipped from mill.	Sawed from 36-inch tree.
	Per cent.	*Per cent.*
Firsts and seconds	28	29
Saps and box boards	11	14
Commons	23	22
Shipping culls	24	23
Mill culls	14	12

APPLICABILITY OF THE TABLES.

The question of how much varying conditions of timber growth and methods of manufacture modify results, and to what extent Tables II, III, and IV are applicable is of the first importance in this discussion. It is evident that these tables are of little value to the lumberman who drives or rafts his yellow poplar to the mill, because such timber is always more or less damaged by water. But where the logs come to the mill in good condition and are manufactured intelligently, and where the lumber is properly handled in the yard, the actual results should approximate those given in the preceding tables. The only data for comparison, however, were obtained from tallies at a mill in the Cumberland Mountains, Scott County, Va. The method of tracing the timber through the mill and the inspection of the lumber were identical with those employed in the Tennessee mill.

THE VIRGINIA TIMBER.

The Virginia timber was comparatively small, and averages could not be obtained for trees above 32 inches in diameter. The trees grew along slopes and in coves in mixture with hemlock, chestnut, red, black, white, and chestnut oaks, ash, cucumber, and basswood. The logs were hauled to the sawmill on a tram road.

As shown in Table V, the used lengths of the Virginia yellow poplar were uniformly less than from the Tennessee cuttings.

TABLE V.—*Comparison of the used lengths of yellow poplar.*

Diameter breast-high.	Used length.		Diameter breast-high.	Used length.	
	Tennessee.	Virginia.		Tennessee.	Virginia.
Inches.	*Feet.*	*Feet.*	*Inches.*	*Feet.*	*Feet.*
13	36	32	23	57	53
14	37	34	24	58	54
15	39	36	25	59	55
16	41	38	26	60	55
17	44	40	27	60	55
18	46	42	28	61	54
19	49	44	29	62	54
20	52	47	30	62	53
21	54	49	31	63	52
22	55	51	32	63	52

THE VIRGINIA SAWMILL.

The Virginia sawmill was equipped with a single band saw, 14-gauge, seven kerfs per inch; its output averaged about 20,000 board feet daily. Probably 98 per cent of the yellow poplar sawed was in 4/4, 5/4, and 6/4-inch thicknesses, and only 2 per cent was 5/8-inch. No lath was made; the slabs were used for fuel.

THE RESULTS.

Computation of the tallies from the 315 trees which were measured gives the following results:

TABLE VI.—*Graded lumber sawed out of yellow poplar—Virginia, 1905.*

Diameter breast-high.	Firsts and seconds.		Saps.	Wide box boards.	Commons.	Shipping culls.	Mill culls.	Total.	Number of trees tallied.
	8 to 17 inches.	18 inches and up.							
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
13	....	....	8	....	14	64	18	104	5
14	....	....	10	....	19	83	24	136	5
15	....	....	14	....	24	102	31	171	10
16	....	....	18	....	30	120	38	206	14
17	....	....	24	....	38	138	46	246	19
18	8	....	31	....	46	155	53	293	21
19	10	....	42	....	56	173	60	341	26
20	14	....	54	....	68	190	67	393	24
21	20	....	68	2	83	209	73	455	23
22	29	....	84	2	99	228	78	520	28
23	42	....	101	3	118	246	80	590	18
24	58	....	118	7	140	265	82	670	19
25	78	....	133	16	165	285	84	761	19
26	101	....	145	25	193	305	85	854	15
27	128	....	154	33	220	325	88	948	21
28	154	24	160	42	248	344	93	1,065	15
29	179	40	163	52	273	363	100	1,170	9
30	202	60	165	68	295	380	108	1,273	9
31	223	95	165	75	315	395	118	1,386	6
32	239	145	165	88	333	411	126	1,507	9

Comparison of the above table with Table II will show that the Virginia yellow poplar sawed out slightly more lumber than the Tennessee trees of the same diameter, despite the fact that the used lengths were a little longer in Tennessee than in Virginia. This was due solely to the different methods of manufacture employed at the two mills. The

Tennessee mill put a much higher proportion of its yellow poplar into 5/8-inch thicknesses than did the Virginia mill, and this by increasing the saw kerf reduced the board-foot yield of the trees. A rough estimate from a dozen logs will suffice to show the excess of waste in sawing a 16-foot log, 30 inches in diameter at the top, almost entirely into 5/8-inch thicknesses, over the waste from such a log sawed into 4/4, 5/4, and 6/4-inch thicknesses. The volume of a log of the above dimensions, disregarding the taper, is 78½ cubic feet. This is equivalent to the cubic contents of 942 board feet. The average product of the log sawed mostly into 5/8-inch material was only 590 board feet; sawed into 4/4, 5/4, and 6/4-inch material, it yielded 663 board feet. In short, the loss in slabbing, edging, trimming, and from saw kerf was 37 per cent for 5/8-inch material against 30 per cent for 4/4, 5/4, and 6/4-inch material, a difference of 7 per cent. If we allow 4 per cent as the difference in yield of the Virginia and Tennessee mills, due to extra saw kerf in the latter, the two tables approach one another very closely.

TABLE VII.—*Percentage of each grade sawed out of yellow poplar—Virginia.*

Diameter breast-high.	Firsts and seconds.		Saps.	Wide box boards.	Commons.	Shipping culls.	Mill culls.	Total yield of tree.	Number of trees tallied.
	8 to 17 inches.	18 inches and up.							
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	....	....	8	....	13	62	17	104	5
14	....	....	7	....	14	61	18	136	5
15	....	....	9	....	14	59	18	175	10
16	....	....	9	....	15	58	18	206	14
17	....	....	10	....	15	56	19	246	19
18	3	....	11	....	15	53	18	293	21
19	3	....	12	....	16	51	18	341	26
20	4	....	14	....	17	48	17	393	24
21	5	....	15	....	18	46	16	455	23
22	6	....	16	....	19	44	15	520	28
23	7	....	17	....	20	42	14	590	18
24	8	....	18	1	21	40	12	670	19
25	10	....	18	2	22	37	11	761	19
26	12	....	17	2	23	36	10	854	15
27	14	....	16	4	23	34	9	948	21
28	15	2	15	4	23	32	9	1,065	15
29	15	4	14	4	23	31	9	1,170	9
30	16	5	13	5	23	30	8	1,273	9
31	16	6	12	5	23	29	9	1,386	6
32	16	9	11	6	22	27	9	1,507	9

The general tendencies of the Tennessee and Virginia yellow poplar are the same. In Virginia the good grades, firsts and seconds, saps, box boards, and commons, increase steadily from 21 per cent of the total contents of the tree in the 13-inch class to 64 per cent in the 32-inch class, and, except where commons fall off 1 per cent in the 32-inch class, each grade shows a steady rise. The poor grades, shipping culls and mill culls, show a steady decline from 79 per cent in the 13-inch class to 36 per cent in the 32-inch class for the same diameters. The main difference between the Virginia and Tennessee trees was that the Virginia timber yielded 1 to 5 per cent more of the good grades

tnan the Tennessee timber, while in the case of the poor grades the situation was reversed. Firsts and seconds, commons, and mill culls show about the same percentage in both tables; but saps form 1 to 6 per cent more of the tree and mill culls 5 per cent less in the Virginia than in the Tennessee figures. These differences are not wide, and should be attributed not so much to differences in the timber as to variations in methods of manufacture.

VALUES FROM THE VIRGINIA TIMBER.

The same prices were employed for the Virginia as for the Tennessee trees, and the 5/8-inch material was not separately computed. The table of values computed for the Virginia timber is the following:

TABLE VIII.—*Values of yellow poplar—Virginia, 1905.*

Diameter breast-high.	Amount sawed out.	Value per tree.	Value per thousand board feet.	Diameter breast-high.	Amount sawed out.	Value per tree.	Value per thousand board feet.
Inches.	*Bd. ft.*			*Inches.*	*Bd. ft.*		
13	104	$1.38	$13.27	23	590	$10.61	$17.98
14	136	1.81	13.31	24	670	12.57	18.76
15	171	2.31	13.51	25	761	14.90	19.58
16	206	2.81	13.64	26	854	17.35	20.32
17	246	3.43	13.94	27	948	19.80	20.89
18	293	4.35	14.85	28	1,065	23.25	21.83
19	341	5.23	15.34	29	1,170	26.22	22.41
20	393	6.22	15.83	30	1,273	29.23	22.96
21	455	7.53	16.55	31	1,386	32.74	23.62
22	520	8.93	17.17	32	1,507	36.70	24.35

As shown by comparison of Tables IV and VIII, the Virginia yellow poplar yielded lumber of a slightly higher value than the Tennessee timber. Some of this difference was due to the fact that the higher priced 5/8-inch material formed a considerably larger proportion of the mill product in Tennessee than it did in Virginia. In order to determine to what extent figuring separately the 5/8-inch material would have changed the Tennessee table of values, 5/8-inch boards were computed separately in several diameters. In the small trees so little of this material was taken that the change in the figures is comparatively small. In the 30-inch class it raises the value per thousand feet from $21.90 to $22.92, which is practically the value of Virginia timber of the same diameter. In the 59-inch class the 5/8-inch material raises the Tennessee "value per thousand feet" from $33.56 to $36.29.

The Virginia trees, though somewhat shorter than the Tennessee trees, sawed out a slightly larger amount, and possibly a somewhat better quality of timber. The difference in the value per thousand feet amounts to 77 cents for a 13-inch tree; for an 18-inch tree it is 65 cents; for a 23-inch tree 71 cents; for a 28-inch tree $1.13, and for a

32-inch tree $1.54. These differences would have been largely made up had the 5/8-inch material been figured separately.

A comparison of results from sawing the same class of logs into different thicknesses of boards would be highly interesting and of considerable value. Unfortunately, in the Tennessee study the method of sawing was irregular. Some logs were put altogether into inch material, some into 4/4, 5/4, 6/4, and 5/8-inch material in irregular proportions. There was no chance for comparison. Unquestionably the 5/8-inch material was more profitable than the thicker boards. The waste in saw kerf was high, and additional handling of lumber (more pieces per thousand feet) raised the cost, but the price was enough to more than compensate for these extra charges.

PRACTICAL APPLICATIONS OF THE VALUE TABLES.

The preceding tables of values give approximately the results from specific lumbering operations of yellow poplar of typical character and growth. The values given are slightly below those actually obtained from the timber, because the 5/8-inch material (worth more than 4/4, 5/4, or 6/4-inch) was not figured separately. Assuming, however, that either table was applicable to a particular timber tract, the lumber manufacturer would undoubtedly find it of value in deciding upon a logging policy for his lands. By comparing the average cost per thousand feet of his lumbering operations with the average value per thousand feet of the lumber sawed from trees of the various diameters, as shown in Tables IV and VIII, he could tell what sizes were profitable and what were unprofitable. In estimating his expenses he should be careful, however, to make the distinction between those that are directly affected by the amount of timber handled and those that are fixed charges. For example, railroad and mill construction, interest on the investment, taxes, and depreciation of the plant are fixed charges, and a reduction of 4 or 5 per cent in the amount of timber removed would leave them practically unaffected. On the other hand, cutting, skidding, hauling, sawing, piling, and loading are charges which depend directly on the amount of timber handled.

As an illustration, let it be assumed that the total expenses per thousand feet of this man's lumbering operation are apportioned as follows:

Stumpage	$5.00
Cutting and peeling	1.00
Hauling of logs from stump to railroad	4.00
Loading on cars, and operation of logging train	.85
All mill and yard expenses	3.15
Fixed charges, including railroad and mill construction, taxes, interest on investment, depreciation of railroad and mill, sales department and executive salaries, etc	2.65
Total expenses per thousand board feet	16.65
Less fixed charges	14.00

The amount properly chargeable against each thousand feet of timber removed would be, according to the above estimate, $15. Every stick of timber yielding lumber of an average value less than that figure would be cut at a loss. Should the timber be of the character of that which forms the basis for Table IV, it could not be cut, without loss, below 18 inches in diameter breasthigh.

The value of the tree and the average value of the lumber it produces increase rapidly with its growth. An 18-inch tree, under the conditions outlined above, would barely be profitable. At 19 inches it would yield an average profit of 82 cents per thousand feet; at 20 inches, $1.32; at 21 inches, $1.99; at 22 inches, $2.67, etc.

In selecting trees to be cut it is not possible to lay down an inflexible rule, for it would be far from correct to assume that in a particular lumbering operation every tree above a certain diameter is profitable and every tree below it unprofitable. Trees of the same diameter, especially hardwoods, differ widely in the amount and quality of their yield. A crooked, knotty, short-boled tree above the diameter limit may not saw out lumber worth the expense of removal, while a straight, sound, clear-boled tree an inch or two below the limit may be well worth taking. The rule specifying a diameter limit is only a guiding rule, to be modified frequently by one having the requisite knowledge of lumbering. The question of removal of unsound timber is also one demanding individual judgment. A doty tree left standing deteriorates in value. The lumberman has paid stumpage for this timber, which would be a dead loss to him if he left the tree. Its removal, if it promises to pay even slightly more than the mere cost of handling, without reckoning in stumpage, would therefore be the best policy.

IMPROVEMENTS IN LOGGING AND MILLING METHODS.

The appearance of each of the logs that passed through the Tennessee mill and the Virginia mill had been carefully described in the woods by the men who measured and marked them. It was, therefore, possible to compare their outward appearance with the class of material they sawed out. The quality increment of the trees, it was observed, was much more easily affected than their quantity increment. A fire or lightning scar, which may not diminish the growth appreciably, will seriously affect the quality of the lumber. Indeed, a damaged tree may have been worth much more at 20 inches than it is now at 30 inches, since the decrease in quality of the lumber has so lowered the value of the tree as to exceed in effect the increase in quantity. A fire or lightning scar, dote, wormholes, a bad stain, or shake may reduce a large part of the lumber from firsts and seconds to shipping culls and mill culls and cut the value of a tree in half.

This suggests improvements in logging methods. A woods superintendent who can judge accurately from the appearance of a log what kind of lumber is inside it is in a position to save his employer a great deal of money. He can do this largely by a better arrangement of his log lengths. Too many 14- and 16-foot logs come to the mill which are clear at the ends but have a bad defect in the middle. Much of the lumber from these logs is reduced in grade because of the single defect, which, on account of its location, can not be trimmed away. A tree may be damaged 25 per cent by such a mistake. If only one side of a long log is affected, and the defective boards could be trimmed in the mill, the defective part should be put into a short log, say 8 feet long; if the defect is bad and extends throughout the log the piece should be cut out and left in the woods.

Mistakes of the same kind occur in sending crooked logs to the mill. A poor arrangement of lengths leaves a bad crook at the end of a long log. The crooked piece should have been either cut out and left or sent in as a short log. At the end of a long log it is cut almost entirely away in the slabbing process, and the expense of handling the extra weight (crooked long logs are exceedingly troublesome) is practically a dead loss.

Hollow butts also entail a loss. Swollen, hollow, doty, or wormy butts should either be left in the woods or be brought in as short logs.

The profits of milling depend to a considerable extent upon the sawyer, the edgerman, and the trimmer. Many mill owners make the mistake of gauging their sawyer's ability entirely by his speed. It is he who sets the pace for the mill crew, and they must keep up with him; therefore, every extra thousand feet cut reduces the average milling cost. Broadly speaking, however, what the average sawyer gains in speed above the normal cut he loses in the quality of his product, especially if he is sawing valuable timber, such as yellow poplar. In order to get the best results the sawyer must take time to look at his log and turn it on the carriage as often as necessary. The sawyer whose sole aim is to make a big cut is the most expensive man the mill owner can employ for the work.

Rapid sawing necessitates rapid work at the edger and trimmer. Much may be lost by inefficient men at these machines. They handle several thousand boards every day, each of them a separate problem which must be solved instantly. The loss of 1, 2, or 3 cents on a piece of lumber by improper edging or trimming is not much in itself, but when these mistakes accumulate, the aggregate per day is often enough to pay the workman's wages several times. The edgerman has no time to stop and make calculations for each separate board. He stands in front of a stream of boards which he must feed into the machine as fast as the live rollers bring them to him. He can, however, be made

so thoroughly familiar with the principles of his work that a glance at a board as it comes to him will usually be enough to tell him what to do with it.

USE OF THE TABLES IN TIMBER CRUISING.

In making estimates of standing timber, cruisers are accustomed to calculate, for each tree counted, the number of merchantable logs it contains and what each should scale; they then make a reduction for defects, such as crook, dote, hollow, shake, etc. If figures such as those in Table VI were secured which could be made applicable to large tracts, the labors of the cruiser of those tracts might be lessened immensely and the accuracy of his figures enhanced. Instead of making separate calculations of the contents of each tree counted, and separate discounts for defects, he would have only to count the number of yellow poplar trees of each diameter and multiply his figures by the total contents for each diameter, as given in the table. This method would be practicable, of course, only with timber of the same general character as that for which the table was made. It would not do to apply to ridge timber a table based on cove timber, or vice versa, since the size and character of the timber on these types differ too widely.

A LOG RULE FOR SOUTHERN HARDWOODS.

Lumbermen everywhere are keenly interested in the question of how much saw gain they are making over the log rule they employ. Anything, therefore, which will assist them in determining this will be of practical benefit. Although the mill studies in Tennessee and Virginia were made primarily to determine the graded yield and money value of whole trees, yet the fact that every marked log which passed through the two mills in the course of the study was carefully described and its actual board feet contents recorded, has made it possible to formulate a log rule which is based upon the actual sawed output of the logs.

In all, 4,329 sound, straight logs were included, of which yellow poplar formed about 90 per cent, and hemlock, chestnut, and white, black and chestnut oak the remaining 10 per cent. By sound, straight logs is meant those which have no defect visible from the outside and whose contents would not, because of irregularity of form, fall below 10 per cent of the maximum contents in inch boards of the perfect log of that diameter. In short, the class of logs included in the rule were those on which a scaler, using the Doyle rule, would not "knock off" for defects.

No uniform thickness was sawed. About 80 per cent of the timber was sawed into 4/4, 5/4, and 6/4-inch thicknesses, the remainder into 5/8-inch and 8/4 to 4-inch thicknesses. This lack of uniformity should, if anything, add to the value of the results, since it makes them as nearly representative of average conditions of manufacture in a southern hardwood mill as it would ordinarily be possible to secure.

In formulating the rule, separate averages were first made for 12-, 14-, and 16-foot lengths, of diameters from 6 to 50 inches, and the resulting figures were compared up and down the columns for different diameters of the same length, and across the columns for different lengths of the same diameter. The figures were so uniformly consistent that they were finally combined on the basis of a 16-foot length, rounded off by curves, the proper proportions taken for lengths from 8 to 24 feet, and reduced for convenience to multiples of 5.

TABLE IX.—*Log rule for southern hardwoods.*

[Based on actual sawed product of 4,329 logs.]

Diameter.	Length in feet.								
	8.	10.	12.	14.	16.	18.	20.	22.	24.
Inches.	*Bd. f.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
8	25	30	35	40	45	50	55	60	70
9	30	35	40	50	55	60	70	75	85
10	35	45	55	60	70	80	85	95	105
11	45	55	65	75	85	95	105	115	130
12	50	65	75	90	100	115	125	140	150
13	60	70	85	100	115	130	145	160	175
14	70	85	100	120	135	150	170	185	205
15	80	95	115	135	155	175	195	215	235
16	90	115	135	160	180	205	225	250	270
17	100	125	150	175	200	225	250	275	300
18	115	145	175	200	230	260	290	315	345
19	130	160	190	225	255	285	320	350	385
20	145	180	215	250	285	320	355	390	430
21	160	195	235	275	315	355	395	435	475
22	175	220	265	305	350	395	440	480	525
23	190	240	285	335	380	430	475	520	570
24	210	260	310	365	415	465	520	570	625
25	225	280	340	395	450	505	565	620	675
26	245	305	365	425	485	545	605	665	730
27	265	330	395	460	525	590	655	720	790
28	285	355	425	495	565	635	705	775	850
29	305	380	455	530	605	680	755	830	910
30	325	405	485	565	645	725	805	885	970
31	345	430	520	605	690	775	865	950	1,035
32	370	460	550	645	735	825	920	1,010	1,105
33	390	490	585	685	780	880	975	1,075	1,170
34	415	520	625	725	830	935	1,040	1,140	1,245
35	440	550	660	770	880	990	1,100	1,210	1,320
36	465	580	700	815	930	1,045	1,165	1,280	1,395
37	495	615	740	860	985	1,110	1,230	1,355	1,480
38	520	650	780	910	1,040	1,170	1,300	1,430	1,560
39	550	690	825	965	1,100	1,240	1,375	1,515	1,650
40	580	725	870	1,015	1,160	1,305	1,450	1,595	1,740
41	615	765	920	1,070	1,225	1,380	1,530	1,685	1,840
42	645	805	970	1,130	1,290	1,450	1,615	1,775	1,935
43	680	850	1,020	1,190	1,360	1,530	1,700	1,870	2,040
44	715	895	1,075	1,250	1,430	1,610	1,790	1,965	2,145
45	750	940	1,125	1,315	1,500	1,690	1,875	2,065	2,250
46	790	990	1,185	1,385	1,580	1,780	1,975	2,175	2,370
47	830	1,035	1,240	1,450	1,655	1,860	2,070	2,275	2,485
48	870	1,085	1,300	1,520	1,735	1,950	2,170	2,385	2,605
49	910	1,135	1,360	1,590	1,815	2,040	2,270	2,495	2,725
50	950	1,190	1,425	1,665	1,900	2,140	2,375	2,615	2,850

TABLE X.—*Doyle-Scribner rule compared with actual sawed product of logs.*

[Basis, 16-foot log.]

Diameter.	Doyle-Scribner rule.	Sawed out.	Saw gain.	
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Per cent.*
8	16	45	29	181
9	25	55	30	120
10	36	70	34	94
11	49	85	36	73
12	64	100	36	58
13	81	115	34	42
14	100	135	35	35
15	121	155	34	28
16	144	180	36	25
17	169	200	31	18
18	196	230	34	17
19	225	255	30	13
20	256	285	29	11
21	289	315	26	9
22	324	350	26	8
23	359	380	21	5.8
24	400	415	15	3.8
25	441	450	9	2
26	484	485	1	.2
27	530	525	−5	−1
28	582	565	−17	−3
29	609	605	−4	−.7
30	657	645	−12	−1.8
31	710	690	−20	−2.8
32	736	735	−1	−.1
33	784	780	−4	−.5
34	800	830	30	3.8
35	876	880	4	.5
36	923	930	7	.8
37	1,029	985	−44	−4.3
38	1,068	1,040	−28	−2.6
39	1,120	1,100	−20	−1.8
40	1,204	1,160	−44	−3.7
41	1,272	1,225	−47	−3.7
42	1,343	1,290	−53	−4
43	1,396	1,360	−36	−2.6
44	1,480	1,430	−50	−3.4
45	1,518	1,500	−18	−1.2
46	1,587	1,580	−7	−.4
47	1,656	1,655	−1	−.06
48	1,728	1,735	7	.4

PART II.—GRADES AND AMOUNT OF LUMBER SAWED FROM ADIRONDACK HARDWOODS.

Graded tallies were made at the Adirondack mill of yellow birch, sugar maple, and beech trees from typical hardwood lands in the manner already described for yellow poplar. The inner part of each 8-foot log and each 16-foot log was put into ties, and the rest of the log into lumber of 5/4-inch thickness. Logs 12 and 14 feet long were made entirely into lumber. The inspection rules followed were those of the National Hardwood Lumber Association.

The mill in the past had been used only for sawing spruce. Consequently, the handling of the timber by the sawyer, and the work of the edgerman, were not as efficient as they commonly are in a well-equipped hardwood mill. The logs themselves were not in perfect condition, but had suffered somewhat from checking. All things considered, the results obtained are certainly below the average ordinarily attainable in an Adirondack band mill sawing hardwoods.

The graded yields of the trees are shown in Tables XI to XVI.

TABLE XI.—*Graded lumber sawed out of yellow birch—Adirondacks, 1904.*

Diameter breast-high.	Firsts and seconds red.	Firsts and seconds.	Commons.	Shipping culls.	Mill culls.	Sound ties.	Total.	Number of trees tallied.
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
13	....	3	5	6	20	25	59	7
14	....	7	7	7	37	37	93	16
15	....	11	10	8	41	55	125	23
16	....	16	12	8	38	72	146	32
17	....	22	14	8	35	84	163	32
18	2	28	17	9	36	94	186	57
19	4	36	20	10	45	102	217	50
20	8	44	24	11	55	108	250	39
21	23	54	28	13	65	114	297	40
22	26	66	31	15	74	119	331	46
23	36	78	33	16	82	118	363	25
24	48	86	36	18	88	112	388	37
25	62	92	38	19	93	104	408	30
26	81	97	42	20	98	96	434	24
27	101	103	47	22	106	91	470	28
28	116	110	53	22	118	86	505	16
29	128	120	59	23	134	81	545	4
30	139	132	64	24	155	74	588	12
31	150	144	68	25	180	52	619	4

TABLE XII.—*Percentage of each grade sawed out of yellow birch—Adirondacks.*

Diameter breast-high.	Firsts and seconds red.	Firsts and seconds.	Commons.	Shipping culls.	Mill culls.	Sound ties.	Total yield of tree.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	....	5	8	10	34	42	59	7
14	....	7	7	7	39	39	93	16
15	....	9	8	6	33	44	125	23
16	....	11	8	5	26	49	146	32
17	....	13	9	5	21	52	163	32
18	1	15	9	5	19	51	186	57
19	2	17	9	5	21	47	217	50
20	3	18	10	4	22	43	250	39
21	8	18	9	4	22	38	297	40
22	8	20	9	5	22	36	331	46
23	10	21	9	4	23	33	363	25
24	12	22	9	5	23	29	388	37
25	15	23	9	5	23	25	408	30
26	19	22	10	5	23	22	434	24
27	21	22	10	5	23	19	470	28
28	23	22	10	4	23	17	505	16
29	23	22	11	4	25	15	545	4
30	24	22	11	4	26	13	588	12
31	24	23	11	4	29	8	619	4

TABLE XIII.—*Graded lumber sawed out of sugar maple—Adirondacks, 1904.*

Diameter breast-high.	Firsts and seconds.	Commons.	Shipping culls.	Mill culls.	Sound ties.	Total.	Number of trees tallied.
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
14	6	12	5	21	75	119	14
15	8	14	5	23	92	142	28
16	15	16	6	25	100	162	18
17	24	18	7	29	106	184	34
18	35	21	8	33	110	207	33
19	47	25	10	37	113	232	20
20	60	29	11	41	114	255	28
21	78	33	13	44	115	283	16
22	97	38	16	53	115	319	22
23	115	43	20	62	114	354	18
24	129	48	23	71	111	382	9
25	143	52	26	82	107	410	9
26	156	56	28	92	98	430	4
27	171	60	30	99	85	445	5
28	186	64	31	108	58	447	3

TABLE XIV.—*Percentage of each grade sawed out of sugar maple—Adirondacks.*

Diameter breast-high.	Firsts and seconds.	Common.	Shipping culls.	Mill culls.	Sound ties.	Total yield of tree.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
14	5	10	4	18	63	119	14
15	6	10	4	16	64	142	28
16	9	10	4	15	62	162	18
17	13	10	4	16	57	184	34
18	17	10	4	16	53	207	33
19	20	11	4	16	49	232	20
20	24	11	4	16	45	255	28
21	28	11	5	16	41	283	16
22	30	12	5	17	36	319	22
23	32	12	6	18	32	354	18
24	34	12	6	19	29	382	9
25	35	13	6	20	26	410	9
26	36	13	7	21	23	430	4
27	38	14	7	22	19	445	5
28	42	14	7	24	13	447	3

TABLE XV.—*Graded lumber sawed out of beech—Adirondacks, 1904.*

Diameter breast-high.	Firsts and seconds.	Commons.	Shipping culls.	Mill culls.	Sound ties.	Total.	Number of trees tallied.
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
13	2	6	4	29	42	83	12
14	4	8	5	30	68	115	55
15	7	10	6	31	88	142	52
16	10	13	7	34	103	167	56
17	15	16	9	36	113	189	44
18	22	19	11	41	118	211	46
19	33	22	14	48	123	240	25
20	47	26	18	57	127	275	24
21	62	31	20	67	134	314	16
22	77	38	24	78	142	359	5
23	96	51	26	88	153	414	6
24	106	70	30	99	168	473	4

TABLE XVI.—*Percentage of each grade sawed out of beech—Adirondacks.*

Diameter breast-high.	Firsts and seconds.	Commons.	Shipping culls.	Mill culls.	Sound ties.	Total yield of tree.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	2	7	5	35	51	83	12
14	3	7	4	27	59	115	55
15	5	7	4	22	62	142	52
16	6	8	4	20	62	167	56
17	8	8	5	19	60	189	44
18	10	9	5	19	56	211	46
19	14	9	6	20	51	240	25
20	17	9	7	21	46	275	24
21	20	10	6	21	43	314	16
22	21	11	6	22	40	359	5
23	23	12	6	21	38	414	6
24	22	15	6	21	36	473	4

TENDENCIES INDICATED BY THE ADIRONDACK TABLES.

The advantage of putting the inner part of each log into ties is apparent. If sawed into lumber the core of the log would have made principally culls and mill culls, worth less per thousand feet than ties, and there would have been the loss in saw kerf, and the added expense of sawing. Had there been no market for ties the logs would have been sawed altogether into lumber and the proportion of low grades would have been increased.

These tables show the rate at which the various grades advance with the growth of the tree. For example, in the case of yellow birch the fancy grade firsts and seconds red, worth about $33 per thousand feet, does not occur in trees smaller than 18 inches. An 18-inch tree contains only 2 feet, or 1 per cent of it; a 19-inch tree 4 feet, or 2 per cent; a 20-inch tree 8 feet, or 3 per cent. But in a 21-inch tree the amount of red birch rises to 23 feet, or 8 per cent of the contents of the tree. This increase goes on to the highest diameter shown in the table, 31 inches, at which red birch comprises 24 per cent of the tree.

The next best grade of birch, firsts and seconds, not graded by color, is contained in all diameters, but rises steadily from 3 feet, or 5 per cent, in a 13-inch tree, to 144 feet, or 23 per cent, in a 31-inch tree. Commons rise from 5 feet, or 8 per cent, in a 13-inch tree, to 68 feet, or 11 per cent, in a 31-inch tree.

With the growth of the tree the percentage of the good grades, firsts and seconds, both heart and sap, and commons combined increases steadily, while the percentage of poor grades, shipping culls, and mill culls falls off. For example, the good grades of yellow birch increase from 13 per cent in a 13-inch tree to 58 per cent in a 31-inch tree; while the poor grades, including ties, drop off from 86 per cent to 40 per cent between the same diameters. The decrease in the poorer grades is, however, somewhat irregular. In the case of sugar maple the good grades rise from 15 per cent in a 14-inch tree to 56 per cent in a 28-inch tree; and in the case of beech from 9 per cent in a 13-inch tree to 37 per cent in a 24-inch tree. These facts bring out the interesting conclusion that the early life of the Adirondacks hardwoods is spent in growing wood which has little commercial value, while after a merchantable size has been reached the growth increment consists of a far higher proportion of valuable grades.

Under the column "Sound ties" is given the board feet in ties 7 by 9 inches, 8 feet long, equivalent to 42 board feet each. In the case of yellow birch the percentage of the tree put into ties was highest at 17 inches, and in maple and beech at 15 inches, from which point there was a steady decline.

VALUES FROM THE ADIRONDACK TIMBER.

In determining the values of the trees sawed, the following price list for hardwood lumber at the mill was used:

Price of Adirondack timber per thousand board feet.

Grade.	Birch.	Maple.	Beech.
Firsts and seconds red	$33	....	....
Firsts and seconds	23	$20	$14
No. 1 common	14	14	10
Shipping culls	8	8	7
Mill culls	6	6	6

The value of the railroad ties was assumed to be 40 cents each, or $9.52 per thousand board feet—a reasonably low price.

The values per tree and per thousand board feet for yellow birch, sugar maple, and beech are given below:

TABLE XVII.—*Values of lumber from Adirondack hardwoods, 1904.*

Diameter breast-high.	Per tree.			Per thousand board feet.		
	Yellow birch.	Sugar maple.	Beech.	Yellow birch.	Sugar maple.	Beech.
Inches.						
14	$0.89	$1.17	$1.00	$9.37	$9.83	$8.70
15	1.22	1.41	1.27	9.76	9.93	8.94
16	1.52	1.68	1.50	10.41	10.37	9.98
17	1.78	1.97	1.72	10.92	10.71	9.10
18	2.18	2.30	1.95	11.45	11.11	9.24
19	2.56	2.66	2.24	11.80	11.47	9.33
20	3.06	3.02	2.60	12.24	11.84	9.45
21	3.98	3.48	2.99	13.40	12.30	9.52
22	4.51	4.01	3.45	13.63	12.57	9.61
23	5.19	4.52	4.02	14.30	12.77	9.71
24	5.80	4.92	4.58	14.95	12.88	9.68
25	6.39	5.30	....	15.66	12.93	....
26	7.15	5.62	....	16.48	13.07	....
27	8.03	5.90	....	17.09	13.26	....
28	8.80	6.07	....	17.43	13.58	....
29	9.57	....	....	17.56	....	....
30	10.34	....	....	17.59	....	....

These tables show that the lumber from the average 24-inch birch tree sawed at the mill was worth $5.58 a thousand feet more than from the average 14-inch tree; in sugar maple the difference between these diameters was $3.05, and in beech 98 cents. The difference is more marked in the case of birch, largely because of the presence of the high-priced grade, firsts and seconds red, in the high diameters. The table for birch gives values from 13 to 31 inches. A lumberman cutting all sizes of birch would, according to these figures, get $8.43 per thousand feet more from his 31-inch trees than from his 13-inch trees.

PROFITS FROM ADIRONDACK LUMBERING.

When a lumberman knows the number of trees of various diameters of each species on his average acre, he is in a position to calculate

closely the profits of lumbering by use of value tables such as Table XVII. Stand tables have been constructed for a number of tracts in the Adirondacks, from which one has been selected for the purpose of illustration. The table of values has been applied to this stand table, and the profits of lumbering have been calculated on the basis of expenses from $10.50 to $12.75 per thousand feet. The results are as follows:

TABLE XVIII.—*Profits from lumbering Adirondack hardwoods in a typical situation.*

Cost of stumpage, logging, and manufacture.	Cutting limit, diameter breast-high.	Yellow birch.		Sugar maple.	
		Profit per acre.	Profit per thousand board feet.	Profit per acre.	Profit per thousand board feet.
	Inches.				
$10.50	17	$9.77	$4.12	$1.51	$1.49
	18	9.72	4.34	1.48	1.68
	19	9.60	4.53	1.40	1.88
	20	9.39	4.80	1.27	2.08
	21	9.13	5.06	1.12	2.25
	22	8.51	5.35	.89	2.39
10.75	17	9.18	3.87	....	....
	18	9.16	4.09	1.26	1.43
	19	9.07	4.28	1.21	1.63
	20	8.90	4.55	1.12	1.83
	21	8.68	4.81	.99	2.00
	22	8.11	5.10	.80	2.15
11.00	18	8.60	3.84	1.04	1.18
	19	8.54	4.03	1.03	1.38
	20	8.41	4.30	.97	1.58
	21	8.23	4.56	.87	1.75
	22	7.72	4.85	.71	1.90
11.25	18	8.04	3.59	....	....
	19	8.01	3.78	.84	1.13
	20	7.92	4.05	.81	1.33
	21	7.78	4.31	.74	1.50
	22	7.32	4.60	.61	1.65
11.50	19	7.48	3.53	.66	.88
	20	7.43	3.80	.66	1.08
	21	7.33	4.06	.62	1.24
	22	6.92	4.35	.52	1.39
11.75	19	6.95	3.28	....	....
	20	6.94	3.55	.51	.83
	21	6.88	3.81	.50	1.00
	22	6.52	4.10	.43	1.15
12.00	20	6.45	3.30	....	....
	21	6.43	3.56	.37	.75
	22	6.13	3.85	.33	.90
12.25	21	5.97	3.31	.25	.49
	22	5.73	3.60	.24	.65
12.50	21	5.52	3.06	....	....
	22	5.33	3.35	.15	.39
12.75	21	5.07	2.81	....	....
	22	4.93	3.10	....	....

Should all birch and maple be cut down to and including 19 inches, there would be, according to the above table, with expenses $11.50 per thousand feet, a profit of $8.14 per acre, of which $7.48 would be from birch and 66 cents from maple. The beech would not pay expenses. The average profit per thousand feet on all trees cut would be $3.53 from birch and 88 cents from maple. On trees 20 inches and over the profit on birch and maple would be $8.09 per acre; on trees 21 inches and over, $7.95, etc. The figures in this table show that while the smaller the cutting limit the higher the profit per acre

(unless trees are taken so small as to cause an actual loss) the lower is the profit per thousand feet on the timber removed; on the other hand, the higher the cutting limit the lower is the profit per acre, but the higher the profit per thousand feet on the timber removed. It must not be forgotten, however, that a considerable reduction in the amount of timber removed per acre, by spreading the operations over a larger area, tends to increase the expense. Figures such as those given in Table XVIII can therefore be only approximately correct.

Nevertheless, the figures furnish the strongest possible argument against careless lumbering. Hardwood lumbering in the Adirondacks is so expensive that as a rule it does not pay to cut any but the larger trees for lumber. It is highly to the advantage of the lumberman to know just at what diameter limit his profits are turned into losses, and it is equally to the advantage of the future productive capacity of the forest that he should know this. These figures prove that the lumberman who would make the highest profits out of the Adirondack hardwoods must cut within certain diameter limits and leave in most cases a considerable stand of timber uncut. With the growing scarcity of timber and the advancing prices of lumber, hardwood lumbering in the Adirondacks soon will be fully developed. It is evident, therefore, that the Adirondack lumbermen, in taking small trees, are working directly against their own interests.

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